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Indian Standard

SPECIFICATION FOR DIGITAL ELECTRONIC DC VOLTMETERS AND DC ELECTRONIC ANALOGUE-TO-DIGITAL CONVERTERS

(First Reprint JULY 1997)

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NEW DELHI 110002

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(Reaffirmed 1995)

Indian Standard

SPECIFICATION FOR DIGITAL ELECTRONIC DC VOLTMETERS AND DC ELECTRONIC ANALOGUE-TO-DIGITAL CONVERTERS

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Indian Standard

SPECIFICATION FOR DIGITAL ELECTRONIC DC VOLTMETERS AND DC ELECTRONIC ANALOGUE-TO-DIGITAL CONVERTERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 July 1977, after the draft finalized by the Electronic Measuring Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard is to specify the performance characteristics of digital electronic measuring instruments for the measurements of direct voltages and to converters, to unify the means of expressing electrical and other functional properties of these types of apparatus and to specify conditions for testing them in order to verify compliance with this standard.

0.3 Certain clauses of this standard may be applicable also to other types of analogue-to-digital converting apparatus, for example, digital ohmmeters and ammeters, but this standard is not intended to provide complete set of technical requirements for these devices.

0.4 This standard is concerned with tests only on the overall performance of apparatus and is not concerned with tests on components.

0.5 This standard does not explicitly consider apparatus with non-linear conversion and some of the requirements may not apply to them.

0.6 Where the term ‘ apparatus ’ is used without any special reference in this standard, it covers both measuring instruments and converters.

Where the term ‘ conversion ’ is used in a general sense without any special reference in this standard, it covers the overall action performed by measuring instruments or converters.

Throughout this standard, wherever ‘ output information ’ is mentioned, the ‘ indication ’ (for example, the output information in visual form) is also implied.

0.7 While preparing this standard assistance has been derived from IEC Pub-485 (1974) ‘ Digital electronic dc voltmeters and dc electronic analogue-to-digital converters ' issued by International Electrotechnical Commission.

0.8 This standard is one of a series of Indian Standards on electronic measuring equipment. A list of standards so far brought out in this series, is given on fourth cover page.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard applies to digital electronic measuring instruments for the measurement of direct voltages (hereinafter referred to as measuring instruments) and systems for data and information processing for the conversion of direct voltages (hereinafter referred to as converters).

1.1.1 This standard does not apply to apparatus measuring/converting alternating voltages.

1.2 This standard is also applicable to accessories, when they are associated with apparatus, inasmuch as the calibration of the apparatus has been or may be carried out together with the accessory, the standard being then valid for the combination of the apparatus and its accessory.

1.3 Safety requirements are not dealt with in this standard.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part XLVII)-1977† shall apply.

3. CONSTRUCTIONAL REQUIREMENTS

3.1 Range Indication — In a multirange measuring instrument, the range in use shall be clearly indicated on the front panel (display) of the instrument, preferably by means of a shifting decimal point, to permit direct reading in volts. The symbols for range of the voltages shall be clearly indicated, preferably by a suffix to the visual display (*see* Table 1). The polarity of the negative voltage shall also be suitably indicated.

3.2 Other Constructional Requirements — Under consideration.

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*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary : Part XLVII Digital electronic equipment.

4. GENERAL REQUIREMENTS FOR STATEMENTS ON FUNCTIONAL PERFORMANCE

4.1 Statements of Values and/or Ranges — Values or ranges of performance characteristics shall be stated according to **4.1.1** to **4.1.4**. Values or ranges for influence quantities shall be stated according to **4.1.5** and **4.1.6**.

NOTE — Depending on its application, one and the same quantity may be referred to in this standard as a performance characteristic and as a measured or converted quantity, and also may act as an influencing characteristics.

4.1.1 The manufacturer shall state rated values or rated ranges and, if necessary, effective ranges for all these performance characteristics necessary for the measuring (converting) purpose(s) of the apparatus.

4.1.2 Reference values and/or ranges of influencing characteristics shall be equal to their rated values or rated ranges, unless otherwise stated by the manufacturer.

4.1.3 The effective ranges of these performance characteristics shall be equal to their rated ranges, unless otherwise stated by the manufacturer.

4.1.4 The limit ranges of operation of performance characteristics shall be stated by the manufacturer. When no statement is given, they shall be assumed to be equal to the relevant rated ranges.

4.1.5 The reference values or ranges, the rated ranges of use and the limit ranges of operation, storage and transport for all influence quantities shall be stated.

Details should be given in catalogues, data sheets, etc, on reference, rated and limit values/ranges for those influence quantities only which are considered by the manufacturer to be the most important ones for the intended purpose of the apparatus.

4.1.6 The apparatus may correspond to one group of rated ranges of use for environmental conditions and to another group for mains supply conditions, but this shall be clearly stated by the manufacturer.

4.2 Performance Statements — Performance statements apply only to the effective ranges.

4.2.1 Limits of operating errors (which apply under rated operating conditions) shall be stated. The stated limits of operating error are valid for every combination of values of influence quantities and influencing characteristics within their rated operating conditions.

4.2.2 Limits of instrinsic errors (which apply under reference conditions) may be stated. In the absence of a statement, they are considered to be equal to the limits of operating error.

4.2.3 Limits of influence error and/or variations may be stated. It is particularly useful to state these limits when any influence quantity or influencing characteristic causes a significant part of the operating error. It may be also of interest to state whether any environmental conditions do not contribute to the operating error.

4.2.4 Limits of zero shifts are always included in the operating error. Furthermore, zero shifts should be stated separately, but only when any influence quantity, performance characteristic or change of range causes a significant part of the operating error.

4.2.5 *Limits of the Stability Error in the Output Information and in the Electrical Zero* — The limits of these effects (fluctuation and drift) shall be stated in one of the following ways:

a) By the time interval during which the stated limits of operating error is not exceeded, when the stability error is included in the operating error. In this case a statement on the stability error is recommended when it is a significant part of the operating error.

b) By its limit and the time interval for which this limit applies, when the stability error is not included in the operating error.

4.2.6 Together with the limits of the stability error, it shall be stated whether or not it is permitted to carry out readjustments during the time intervals. The warm-up time is always excluded from these time intervals. Furthermore, the electrical zero may always be adjusted whenever necessary except during tests for measuring zero indication deviations.

4.2.7 Further electrical and other qualities as given in **3** and **6** shall be stated.

4.2.8 As for interrelations between statements on different types of error, the following shall apply:

a) Statements of limits of error components, according to **6.5.1.2**, are optional with the exception of stability error, but these error components are always included in the stated operating error limits;

b) Statement of intrinsic error limits is optional, but intrinsic error is always included in the stated operating error limits;

c) Statements of influence error and/or variation limits are optional, but influence errors and/or variations are always included in the stated operating error limits; and

d) Statements on effects of superimposed voltages are mandatory. These effects are always excluded from the operating error.

5. MARKING

5.1 Markings and Symbols for Apparatus — Making use of the symbols given in Table 1, wherever applicable, each apparatus shall bear on one of its external surfaces, preferably on the front panel, the following markings:

a) Identifying information (such as manufacturer's name. trademark, designation, type, serial number);
b) Upper limits of the effective ranges; and
c) The rated supply voltage and frequency.

If no suitable external surface is available, the apparatus should be marked in such a way as to make possible identifications with the relevant indications in the instruction manual.

5.2 Markings and Symbols for Accessories — Accessories shall bear the following markings.

5.2.1 *Non-interchangeable Accessories*

a) Identifying indication (such as manufacturer's name or trademark);
b) Identification of the apparatus with which it has been calibrated;
c) The upper limits of effective ranges for the combination of apparatus and accessory; and
d) The maximum permissible voltage(s).

5.2.2 *Interchangeable Accessories*

a) Identifying indication (such as manufacturer's name or trademark);
b) The serial number of the accessory; and
c) The maximum permissible voltage(s).

6. TESTS

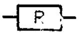
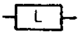
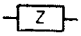
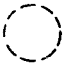
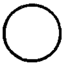
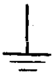
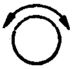
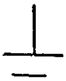
6.1 General Requirements for Tests

6.1.1 Tests specified in this standard are performed in order to verify compliance with technical data given by the manufacturer, and/or with the requirements specified in this standard, as follows:

a) Compliance with the stated operating error and intrinsic error limits (*see* **6.5**);

TABLE 1 SYMBOLS FOR APPARATUS

(*Clause* 5.1)

DESCRIPTION	SYMBOL
1. *Symbols of the units of input signal and their principal multiples*	
a) Kilovolt	kV
b) Volt	V
c) Millivolt	mV
d) Microvolt	μV
2. *Symbols indicating the type of the supply source*	
a) Direct current	—
b) Single-phase alternating current	∼
c) Direct or single-phase alternating current	≂
3. *Miscellaneous symbols*	
a) Series resistor	
b) Series inductor	
c) Series impedance	
d) Electrostatic screening	
e) Magnetic screening	
f) Earth terminal	
g) Electrical zero adjuster	
h) Frame terminal	

b) Compliance with stated influence error, variation and zero shift limits, with the stated limits of stability error in the output information and with the stated limits of stability error of the electrical zero (*see* **6.6** and **6.7**); and

c) Compliance with the stated further performance and other qualities (*see* **3**, **5** and **6.8**).

6.1.2 *Test Procedure*

6.1.2.1 Tests as described in this standard are type tests unless otherwise indicated. If routine or acceptance tests are carried out, they shall also be performed according to this standard.

6.1.2.2 When carrying out type tests, the apparatus shall be subjected to each of the tests laid down in this standard as far as is applicable.

The sequence of tests is not indicated by the order of the clauses.

6.1.2.3 Testing under one or several combinations of values for influence quantities and influencing characteristics will, in most cases, adequately verify that an apparatus has the functional performance defined by the limits of operating error under specified conditions. One of these combinations gives the reference conditions.

Tests are preferably performed under reference conditions which closely approach the conditions under which calibration standards and calibration equipments are normally operated.

6.1.2.4 With multirange apparatus, and unless otherwise specified hereinafter, tests shall be carried out in the most sensitive range and in the highest range. When a built-in amplifier is used to increase the sensitivity for some ranges only, a further test shall be performed in the most sensitive range without the amplifier.

6.1.2.5 In general, measurements for verification shall be carried out with instruments which do not appreciably (or only calculably) affect the values to be measured. In principle, the errors in measurements made with these instruments should be negligible in comparison with the errors to be determined.

When the error of the instrument is not negligible, the following rule should apply:

> If an apparatus is claimed to have a limit of error of $\pm e$ percent for a given performance characteristic and the manufacturer uses for its checking an apparatus resulting in an error of measurement of $\pm n$ percent the error being checked shall remain between the limits $\pm (e - n)$ percent.

Similarly, if a customer checks the same apparatus using another apparatus resulting in an error of measurement of ± *m* percent, he is not entitled to reject the apparatus if its apparent error exceeds the limits ± *e* percent, but remains between the limits ± (*e* + *m*) percent.

6.1.2.6 Where a value of the measured/converted quantity such as the upper limit of the effective range is given for a test, this refers, in general, to the output information, which should therefore be set to this value, and the corresponding input value should be noted.

With some tests, however, it may be advisable to set the input value to the specified value and to note the corresponding output information.

6.1.2.7 If, during a test, the input value is varied in order to obtain a specified output signal, care should be taken to note always the input value which corresponds to a fixed point within the quantization units, that is, a point having fixed distance from the commutation point, in so far as the error to be determined is of the same order as the resolution.

NOTE — In general, this requirement is applicable only for apparatus having a coarse resolution.

6.1.2.8 Wherever 'adjustment' or 'readjustment' is mentioned in this standard, it is understood that adjustments (readjustments) may be made without disassembling the apparatus and only by built-in facilities.

6.2 General Conditions for Tests — Tests are carried out under that combination of the following conditions which produces the maximum error:

a) Protective earth terminals, if any, connected to earth or not, unless the manufacturer has specified the requirement for earthing;

b) For a single-phase ac mains supply, unless otherwise specified, line and neutral leads being interchanged; and

c) Any optional accessories connected to the apparatus or not and being used or not, unless otherwise specified.

NOTE — The influence quantities which are relevant to this standard are given in Appendix A.

6.3 Preparation for Tests — Before tests are performed, the following shall apply.

6.3.1 Before turning on, the apparatus shall be in equilibrium with the temperature and humidity of the ambient air.

6.3.2 The apparatus shall then be operated under reference conditions approaching these for a period equal to the warm-up time as indicated by the manufacturer. In absence of any such indication, this period shall be 15 minutes.

6.3.3 Adjustments, if any, shall be performed according to the manufacturer's instructions.

6.3.4 After this, unless otherwise specified by the manufacturer, an overload shall be applied to the input of the apparatus by applying an input value which is 1·2 times the upper limit of the highest measurement/conversion range. The manufacturer shall state the duration of this test, and in the absence of indication, the overload shall be applied for 2 hours.

6.3.5 After warm-up time and overload, additional preliminary adjustments may be performed by controls provided for that purpose and according to the manufacturer's instructions.

6.4 Reference Conditions and Rated Operating Conditions — The reference conditions and the rated operating conditions, concerning influence quantities which are particularly to be considered with digital voltmeters and analogue-to-digital convertors, are given in Tables 2 and 3, respectively.

TABLE 2 REFERENCE CONDITIONS

INFLUENCE QUANTITY (1)	REFERENCE CONDITION (2)	TOLERANCE ON REFERENCE VALUE (3)
Ambient temperature	27°C	For apparatus with power consumption $\leqslant$ 50 W : ± 1°C $>$ 50 W : ± 2°C
Relative humidity of the air	45 to 75 percent	
Barometric pressure (altitude)	Under consideration	Under consideration
Mains supply voltage	Rated supply voltage	± 1 percent
Mains supply frequency	Rated frequency	± 1 percent
AC mains supply distortion*	Zero (sinusoidal voltage)	$\beta = 0{\cdot}05$ whilst maximum peak value deviation does not exceed 2 percent
Ripple of the dc input signal	Zero	Negligible compared with the accuracy of the quantity under test
Source impedance	—	Negligible

*The distortion is determined by a factor β in such a way that the waveform is inside an envelope formed by:

$y_1 = (1 + B). A. \sin \omega t$, and

$y_2 = (1 - B). A. \sin \omega t$.

TABLE 3 RATED OPERATING CONDITIONS

(*Clause* 6.4)

INFLUENCE QUANTITY	RATED OPERATING CONDITION	REMARKS
(1)	(2)	(3)
Ambient temperature	+ 10°C to + 40°C	The combinations of extreme values of temperature and humidity may be restricted
Relative humidity of the air	20 percent to 80 percent excluding condensation	
Barometric pressure (altitude)	70·0 to 106·0 kPa (up to 2 200 m)	
Mains supply voltage	Rated supply voltage ± 10 percent	If so agreed, tests on transients are performed following abrupt changes of + 10 percent and − 10 percent of rated voltage
Mains supply frequency	Rated frequency ± 5 percent	
AC mains supply distortion	$\beta = 0{\cdot}05$	The peak value shall not differ by more than 12 percent from its rated value
Primary battery	80 percent of the rated supply voltage	—
Source impedance	Maximum rated source impedance	—

6.5 Operating Error and Intrinsic Error of Apparatus

6.5.1 *Error Indication and Evaluation*

6.5.1.1 The error shall be stated as one part given as percentage of the actual reading plus another part given as a percentage of the maximum value of the effective range (that is, $\pm X$ percent of reading $\pm Y$ percent of M. V. E. R.) or as a percentage of the actual reading plus a number of representation units (that is $\pm X$ percent of reading $\pm Y$ representation unit).

NOTE 1 — The first part of each will represent the effect of the error of the conversion coefficient, whilst the second part will represent the combined effect of the remaining error elements.

NOTE 2 — The determination of errors of apparatus with an intentionally non-linear characteristic is under consideration.

6.5.1.2 The statement of error as in **6.5.1.1** shall consider all the following errors:

a) Resolution error (considering dead zone);

b) Commutation error;
c) Hysteresis error;
d) Error of the conversion coefficient;
e) Linearity error;
f) Zero indication error; and
g) The stability error if it is included in the operating error. If this error is not included (*see* **4.2.5**), the fact should be clearly stated.

NOTE 1 — Some of the above errors may be considered as systematic errors, and others as random errors.

NOTE 2 — Procedures involving repeated measurements, to minimize the effects of random errors, are not covered in this standard.

6.5.1.3 For apparatus having a sufficiently fine resolution compared with the error (variation) to be determined, an appropriate input signal shall be applied and the output observed.

For apparatus having a coarse resolution, a variable input signal shall be used and its value at an appropriate output indication observed. In this case, the relation between the input value and the output indication is established as follows:

a) For the determination of the error, the input value at which the output jumps to the next higher value and that at which it jumps to next lower value shall be used. Neither of these input values shall be outside the error limits.
b) For the determination of variations and drift, for example when two successive input values are to be compared, the input value at which the output jumps to the next higher value or that at which it jumps to the next lower value shall be used consistently.
c) For the adjustment of the zero:
    1) When the zero is within the output range, the zero shall be so adjusted that equal increments of the input quantity are required to cause the output to jump to the next higher or the next lower indication; and
    2) When the zero is at the end of the output range:
        i) the commutation point is at the centre of each representation unit: the zero shall be so adjusted that half the analogue equivalent of one representation unit is required to cause the output to jump to the next higher indication; and
        ii) the commutation point is at the end of each representation unit: the zero shall be so adjusted that the analogue equivalent of one representation unit is required to cause the output jump to the next higher indication.

d) These methods may, with the appropriate modifications, also be used to determine particular error elements.

6.5.1.4 For the evaluation of the linearity error, either method described below may be used to state the linearity error. The method used shall be explicitly stated.

Verification tests are based on the reference line and the actual sensitivity at the calibration point is recorded.

If the linearity error is given in the form of ' slope error over 10 percent ', the effective range is then divided into 10 equal portions, and for each portion the ' slope error over 10 percent ' is measured. The percentage slope error over 10 percent is:

$$\frac{\tan \gamma - \tan \beta}{\tan \beta} \times 100$$

where

γ is the angle of the 10 percent with the axis of abscissa, and

β is the angle of the reference line with the axis of abscissa.

None of the values determined during this test shall exceed the stated numerical value of linearity error or shall be outside the stated curve.

6.5.2 *Conditions Under Which Errors Shall be Determined* — With the exception of tests concerned with time function or where stated otherwise, all tests shall be performed under steady-state conditions, that is, when any transients have decayed, at sufficiently low values of the conversion rate, and with constant values of the input quantity. The value of the source impedance shall be negligible while testing under reference conditions, and it shall be equal to the maximum rated source impedance while testing under rated operating conditions.

6.5.2.1 *Measurements of the error* — Error measurements may be performed at any value within the effective range. Continuous measurements throughout the effective range may be replaced by measurements at discrete values within that range, as agreed between the manufacturer and the user.

When measuring the intrinsic error, the combination of values and/or ranges shall remain within the reference conditions which include relevant tolerances on reference values.

When measuring the operating error of a performance characteristic, the combination of values and/or ranges shall be chosen according to **6.1.2.3** and shall remain within the rated operating conditions.

6.5.2.2 For multi-range apparatus, measurements of operating errors shall be carried out for each measurement (conversion) range.

If the apparatus may operate in more than one mode, measurements of errors shall be made for each range in each mode. At no point in any effective range shall the error exceed the limits, stated by the manufacturer according to **6.5.1.1**.

6.5.2.3 After switching over to another range, no manual readjustment is permitted:

a) for apparatus with automatic range selection; and

b) for other apparatus, unless explicitly required by the manufacturer.

6.6 Influence Errors and Variations

6.6.1 Tests on influence errors and/or variations of output indication or zero shift due to changes of an influence quantity shall be performed.

6.6.2 Zero shift, if limits for it are stated (*see* **4.2.4**), shall be measured after having connected to the input terminals a two-pole passive network the impedance of which is equal to the maximum rated source impedance.

6.6.3 Under any combination of the influence quantity values within their rated ranges of use and of the input voltage within its rated ranges, it shall be possible to bring the electrical zero to the correct value with the aid of the built-in zero adjuster, after having connected to the input terminals a network as specified in **6.6.2**.

6.7 Stability Errors

6.7.1 *Application of Stability Error Tests* — The tests specified in this clause do not apply to fast analogue-to-digital converters.

6.7.2 *Stability Errors to be Tested*

6.7.2.1 The stability errors are divided into fluctuation, short-term drift and long-term drift, and may apply to the electrical zero and to the output information.

6.7.2.2 Tests on the stability errors of the electrical zero shall be performed when limits for such errors have been separately stated by the manufacturer, that is, if not included in the operating error.

NOTE — Any deviation of the electrical zero will affect any measurement throughout the measurement (conversion) range. Therefore, verification of the stability errors in the output information is sufficient when the deviations of the zero are included in the operating error.

6.7.2.3 Tests on the stability errors in the output information shall be carried out by operating the apparatus as specified in **6.7.3** to **6.7.5** and the following requirements shall be met with:

a) when the stability errors are included in the operating error, none of the noted values shall be outside the limits of operating error, and

b) when the limits of stability error are stated separately, none of the noted values shall be outside these limits.

6.7.3 *Schedule of Tests* — The stability errors of the electrical zero and in the output information, if applicable, shall be determined according to Table 4.

TABLE 4 SCHEDULE FOR THE DETERMINATION OF STABILITY ERRORS

STABILITY ERROR TO BE TESTED (1)	TOTAL TIME OF TEST (2)	NUMBER OF OBSERVATION PERIODS (3)	LENGTH OF ONE OBSERVATION PERIOD (4)	TIME INTERVALS BETWEEN TWO SUCCESSIVE READINGS (5)	VALUE TO BE NOTED (6)
Fluctuation	Not less than 100 min	1	So as to obtain 100 conversions	Reciprocal of highest conversion rate or any convenient value approaching this rate	Average value, calculated over 100 readings, and maximum deviation of any indicated value from that average value
Drift (short-term or long-term as applicable)	1 h 3 h 7 h >7 h	12* 36 60 60	1 min	Approx. 5 s (corresponding to 12 readings per observation period)	Average value for each observation period and the difference between the maximum and the minimum of these average values

*Equally distributed over the total test time.

6.7.4 *Durations of Tests* — Test durations for the determination of short-term and long-term drift shall be equal to the related time interval stated by the manufacturer and shall be chosen from the following values:

1 hour,	10 days,	3 months,	1 year.
3 hours,	30 days,	6 months,	
7 hours,			
24 hours,			

However, they shall not be less than the following:

a) 1 hour for zero position short-term drift,

b) 7 hours for zero position long-term drift,

c) 7 hours for output information short-term drift, and

d) 6 months for output information long-term drift unless otherwise specified by the manufacturer.

6.7.5 *Conditions of Tests*

6.7.5.1 Test on stability errors shall be carried out under reference conditions or under conditions approaching these.

6.7.5.2 For tests on the stability error of the electrical zero, the input terminals shall be connected to a network as specified in **6.6.2**. No zero or calibration adjustments are permitted during these tests.

6.7.5.3 For tests on the stability error in the output information, the input terminals shall be connected to an external calibration voltage source so as to result in an indication of about 80 percent of the upper limit of the effective range in the most sensitive range (for the most sensitive ranges, *see* **6.1.2.4**).

During output information short-term drift tests, no zero or calibration adjustments are permitted. During tests on long-term drift, which may contain operative and inoperative intervals, zeroing or calibration adjustments that are part of the normal operating procedure are permitted; however, no adjustment bv external means or of only internally accessible parts are permitted.

6.7.6 *Additional Tests on the Zero Position*

6.7.6.1 Following the above tests, the electrical zero shall be readjusted. A signal corresponding to the upper limit of the most sensitive range shall then be applied to the input terminals for 1 hour. After 1 hour, the input signal shall be disconnected. During 1 minute following the disconnection, the deviations of the electrical zero shall be observed and their average value shall be noted.

The average deviation shall not exceed the limits stated by the manufacturer.

6.7.6.2 The electrical zero shall be observed for all ranges by passing from the most sensitive range to all others, and the maximum deviation shall be noted.

The maximum deviation shall not exceed the limits stated by the manufacturer.

6.8 Further Requirements Concerning Statements and Tests on Apparatus — Tests as described or referred to in this clause shall be performed under reference conditions, or under conditions approaching these.

6.8.1 *Input Impedance and Impedances to Common Points* — Measurements of impedances stated according to 9 (b) of Table 5 shall be carried out for each range at the input terminals of the apparatus.

If these admittances/impedances are considerably influenced by such factors as the rate of change of the input value, the magnitude of the input value or by the time function of the apparatus, sufficient information on these changes shall also be given by the manufacturer.

Concerning the changes in these impedances during measuring time, the manufacturer shall specify the maximum and minimum values of the input impedance values during the measuring period.

The values of the input admittances/impedances shall be specified also when the apparatus is in non-operating condition.

The values of the input resistances shall not be lower and the values of the parallel input capacitances shall not be higher than those indicated by the manufacturer.

If the input impedances or resistances are specified with tolerances, which is of special importance when they are of low values, they shall be between the limits indicated by the manufacturer.

6.8.2 *Determination of Series Mode and Common Mode Interference*

6.8.2.1 *Effect of series mode interference* — The effect of the superimposed signal is determined by applying to the input terminals of the apparatus the series combination of a dc signal source (to supply direct voltage for the measurement of which the apparatus is intended) and an ac signal source (to supply the interfering/alternating voltage).

The frequency of the ac signal source shall be that of the mains supply within the stated tolerances. In addition, the manufacturer may state the rejection factor as a function of frequency. Compliance tests shall be carried out at frequencies agreed upon by the manufacturer and the user.

If there is a filter in the apparatus, the bandwidth of which may be changed, for example by means of a switch, the rejection factor at quoted frequencies shall be stated for each of the bandwidths.

The phase of the ac signal shall be adjusted so as to result in the maximum effect.

The voltage provided by the dc signal source shall be varied throughout the most sensitive range or the most sensitive ranges (*see* **6.1.2.4**) of the apparatus under test to determine whether the series mode rejection factor is a function of the applied direct input voltage. If this is so, the manufacturer shall state this relationship.

The magnitude of the series mode alternating test voltage shall be large enough to cause a change in the output information, but in the absence of statements by the manufacturer on the maximum permissible alternating and direct voltages for this test, the sum of the applied direct voltage plus the peak value of the alternating voltage shall exceed neither the upper nor the lower limit of the measurement/conversion range.

6.8.2.2 *Effect of common mode interference* — This clause is applicable not only to apparatus with difference and/or floating input circuits but also to apparatus having inputs with isolated common point; in the latter case, restriction on output connection should be specified.

Test shall be carried out with alternating and direct common mode voltages for the input configurations shown in Fig. 1. The common mode rejection factor shall be determined for at least dc and ac of mains frequency and shall be within the stated tolerances.

If there is an input filter in the apparatus, the bandwidth of which may be changed, for example by means of a switch, the rejection factor shall be stated for each of the bandwidths at quoted frequencies. The phase of the ac signal shall be adjusted until maximum effect is obtained.

The magnitude of the common mode test signal shall be large enough to cause a change in the output information, but care shall be taken that the maximum permissible input voltage is not exceeded. The maximum values of the dc tests signal and of the ac test signal (peak value) shall be specified by the manufacturer, as well as the unbalance resistance R_u (*see* Fig. 1). If the common mode rejection factor is a function of the test voltage or of the signal voltage between the measuring terminals, the worst case shall be specified for voltages up to the upper limits of each effective range.

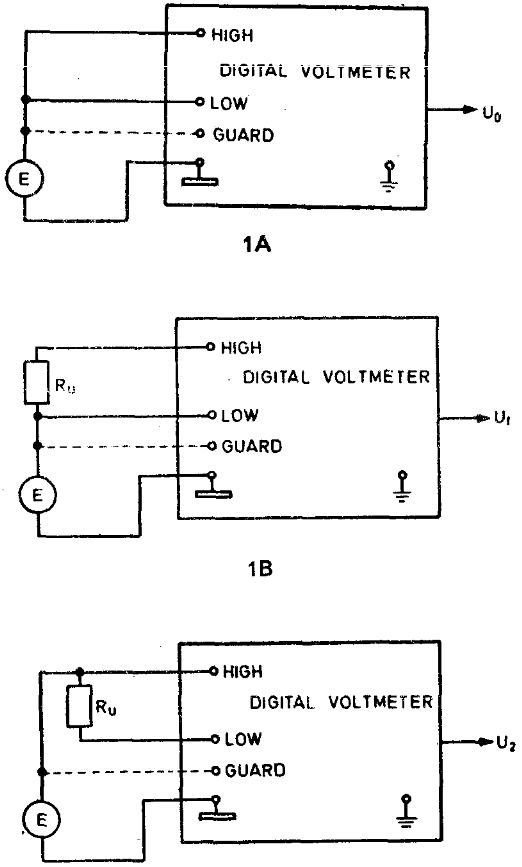
Designating the value (peak value) of the common mode voltage with E, and the input voltages which would produce the same output information with U_0, U_1 and U_2 corresponding to measurement configurations of Fig. 1A, 1B and 1C respectively, the following common mode rejection factors shall be specified:

$$\frac{E}{U_0} \text{ or, preferably } 20. \log \frac{E}{U_0} \text{ dB}$$

$$\frac{E}{U_1} \text{ or, preferably } 20. \log \frac{E}{U_1} \text{ dB}$$

$$\frac{E}{U_2} \text{ or, preferably } 20. \log \frac{E}{U_2} \text{ dB}$$

6.8.3 *Spurious Feedback or Noise at the Input* — The manufacturer shall state the characteristics of any noise or other signal, such as spurious feedback emanating from the input terminals of the apparatus or from the input terminals of any auxiliary accessory.



1A

1B

1C

$_0$ = analogue (input) equivalent of the output information

U_1 = analogue (input) equivalent of the output information

U_2 = analogue (input) equivalent of the output information

Unless otherwise specified, the value of the unbalance resistor R_u is 1 kΩ

NOTE — When a guard terminal is provided, it shall be connected according to the broken line.

FIG. 1 INPUT CONFIGURATIONS

If this quantity has a definite spectral distribution or is different for different ranges or modes, complete information on these shall also be supplied. The values measured during the tests shall not exceed the stated values.

NOTE 1 — Method of measurement is under consideration.

NOTE 2 — The purpose is to avoid interference with other measuring equipment that may be connected to the same terminals at the same time, and to avoid damage to other items, such as sensitive solid state devices, standard cells, etc, that may also be connected.

6.8.4 *Determination of Time Function*

6.8.4.1 *Conversion rate* — A constant input voltage equal to the upper limit of the effective range (of the most sensitive and of the highest ranges) for a multi-range apparatus (*see* **6.1.2.4**) is applied and the apparatus is, by internal or external means, caused to convert this signal. The maximum rate of conversions that may be obtained with a deviation not exceeding the limit of operating error shall be not less than the stated maximum conversion rate.

NOTE — This test shall not be understood as giving an indication of the performance of the apparatus when the input voltage is varied.

6.8.4.2 *Response time* — Where the response times are different for increasing and decreasing steps or at different ranges, they shall either be specified individually or the longest time shall be specified. Polarity response time and range response time are applicable only for apparatus with automatic polarity and range change respectively. When testing response time, the apparatus shall be operated at the maximum conversion rate.

The following response time measurements are relevant:

a) *Step response time* — This shall be measured by applying to the input signal, a step change with a magnitude equal to 80 percent of the upper limit of the effective range. The initial value of the input signal shall be 15 percent of the upper limit of the effective range.

b) *Polarity response time* — This shall be measured by applying a step change with a magnitude of about 10 percent of the upper limit of the effective range. The initial value of the input signal should be approximately ± 5 percent of the upper limit of the effective range. The step change shall be of the opposite polarity to the initial signal.

c) *Range response time* — This shall be measured by applying a step change with a magnitude of about 10 percent of the upper limit of the effective range. The initial value of the input signal should be approximately 95 percent of the upper limits of the effective range for changes from a lower range to a higher one and not less than 5 percent of the upper limit of the effective range for changes from a higher range to a lower one.

d) *Recovery time* — The test shall be performed as in (a) but the step change shall decrease the input voltage from the overload specified by the manufacturer to 20 percent of the upper limit of the effective range. For apparatus with automatic range-changing, this test shall be carried out in the highest range only.

6.8.5 *Determination of the Commutation Point of the Representation Unit* — This test applies only to apparatus having the zero within the effective range. It does not apply to apparatus having the zero at one end of the effective range or having a suppressed zero.

The test shall be performed by comparing the change of input quantity necessary to shift the output information from −1 to +1 and the change necessary to shift it from +1 to +2.

6.8.6 *Storage and Transport Conditions* — Under consideration.

7. EXPRESSION OF CHARACTERISTICS

7.1 General Requirements — Properties of apparatus as specified in this standard shall be expressed by using the terms, in accordance with the definitions given in **2**, as listed below. This applies especially to statements given by the manufacturer such as those contained by data sheets, catalogues and instruction manuals.

The instruction manuals shall comply with IS : 6756-1972*.

7.1.1 Properties shall be stated according to the principles and methods laid down in 'Indian Standard expression of performance of electronic measuring equipment' (*under preparation*) as well as directions given in **3**, **4** and **6**. Facilities for which statements are not made are deemed not to be available. Quantities for which statements are not made are deemed to be of any value.

7.1.2 Values for which limits are not given are deemed to be informative data only. It is preferred that such values are marked by suitable prefix, such as ' typical ' or ' approximate '.

7.1.3 The properties for which statements shall be made in the instruction manual are listed in Table 5. Those marked with the symbol ' *m* ' indicate ' mandatory ' and those marked with the symbol ' *o* ' indicate ' optional '.

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*Technical documentation to be supplied with electronic measuring equipment.

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL

Sl No.	Term	Unit	Answer or Remarks	Reference to Test Clauses	Statement
(1)	(2)	(3)	(4)	(5)	(6)
1.	*General*				
	a) Manufacturer	—	Name and/or trade-mark	—	*m*
	b) Type and serial number	—	—	—	*m*
	c) Designation	—	Digital voltmeter or analogue-to-digital convertor		*m*
	d) Measured/converted quantity	—	Direct voltage	—	*m*
2.	*Measurement/conversion performance*				
	a) Effective ranges	—	State all ranges in the form 0...99·99 mV or −99·99......0 + 99·99 mV, with statements on range setting hysteresis, if any, for apparatus with automatic range setting	—	*m*
	b) Parts of measurement / conversion ranges beyond the effective ranges	—	State each such range in the form 1·00...1·99 mV or −1·99 −1·00 mV and 1·00...1·99 mV	—	*m*
	c) Commutation point	—	At the centre or at the end of each representation unit	—	*o*
	d) Output	—	Electrical and/or visual	—	*m*
3.	*Conversion characteristics*				
	a) Kind of conversion	—	Linear or non-linear	—	*m*
	b) Operating principle	—	Instantaneous or integrating e.g. linear ramp type	—	*m*
	c) Basic mode(s) of operation	—	Triggered, repetitive or tracking	—	*m*
	d) Range setting	—	Manual or automatic	—	*m*

(Continued)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

Sl No.	Term	Unit	Answer or Remarks	Reference to Test Clauses	Statement
(1)	(2)	(3)	(4)	(5)	(6)
	e) Polarity setting	—	Setting by hand, indication only or automatic setting	—	*m*
	f) Resolution	Volt	—	—	*m*
	g) Conversion coefficient	Volts per representation unit	—	—	*o*
4.	*Visual representation*				
	a) Number of digits	—	—	—	*m*
	b) Number of representation units within the measurement (conversion) range	—	State for all ranges. [The number of representation units is not necessarily a power of 10 of the number of digits (For example, if the output jumps 0-5-0 at the last digit)]	—	—
	c) Means of representation of the output value, also size	mm × mm	—	—	*m*
	d) Means of polarity representation	—	—	—	*m*
5.	*Electrical representation of the result*				
	a) Output code	—	For example, BCD-code	—	*m*
	b) Output components	—	For example, relays	—	*o*
	c) Output system	—	For example, series, parallel, bit series—character parallel	—	*m*
	d) Readout clock-rate	Bit(s) or character(s)		—	*m*

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

SL No.	TERM	UNIT	ANSWER OR REMARKS	REFERENCE TO TEST CLAUSES	STATEMENT
(1)	(2)	(3)	(4)	(5)	(6)
	e) Output connection	—	Floating or one terminal grounded and if applicable maximum floating voltage	—	*m*
	f) Output terminals	—	—	—	*m*
	g) 'Zero' and 'one' levels and polarity	V, Ω	—	—	*m*
	h) Voltage characteristics	—	For example, rise time	—	*m*
	j) Permissible load	A	State	—	*m*
	k) Permissible switching conditions	V, A	State if different for ac and dc	— —	*m* *m*
6.	*Warm-up time*	Minutes		—	*m*
7.	*Operating conditions*	—	To be stated as specified in **4.1.5** Further effects shall also be specified if they have considerable influence on the performance of the apparatus, for example, for some types of apparatus a statement is necessary also on the maximum permissible rate of change of the input voltage, as a part of the statements on the rated operating conditions	—	*m*
8.	*Accuracy*				
	a) Operating error	%	In the form percentage of M.V.E.R. + percentage of reading in accordance with **6.1.1**. State if different for different ranges of modes	6.5	*m*

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

Sl No.	Term	Unit	Answer or Remarks	Reference to Test Clauses	Statement
(1)	(2)	(3)	(4)	(5)	(6)
	i) Components of error		As required, for example, linearity error in percentage with reference to the method of measurement (for example, 'differential error of the slope, maximum or limits given by drawing')	6.5	*o*
	b) Intrinsic error	%	Statements should be made as for operating error [*see* (a) above]	6.5	*o*
	c) Influence errors and/or variations due to changes of influence quantity	%		6.6.1	*o*
	d) Shift of the electrical zero due to changes of an influence quantity	Representation units		6.6.2 6.6.3	*o* but *see* **4.2.4**
	e) Zero adjustment	—	State zero adjusting facilities		*m*
	f) Stability error of the electrical zero	—	State whether included in the operating error or not	6.7	*o* but *see* **4.2.5**
	i) Fluctuation	Representation unit		6.7.5.1	
	ii) Short-term drift	Representation units	State the interval (min 1 h)	6.7.4 to 6.7.5.1	---
	iii) Long-term drift	Representation units	State the interval (min 7 h)	6.7.4 to 6.7.5.1	
	g) Stability error in the output information:		State whether included in the operating error or not	6.7	*o* but *see* **4.2.5**
	i) Fluctuation of the output information	Representation units		6.7.1	

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

SL No.	TERM	UNIT	ANSWER OR REMARKS	REFERENCE TO TEST CLAUSES	STATEMENT
(1)	(2)	(3)	(4)	(5)	(6)
	ii) Short-term stability error	Representation units	State the interval (min 7 h)	6.7.1	
	iii) Long-term stability error	Representation units	State the interval	6.7.1	
	h) Effects of series mode and common mode interference				
	i) Common mode rejection factor	dB	State the frequency dependence within the stated tolerances, the unbalance impedance as well as other conditions for test	6.8.2.2	*m*
	ii) Series mode rejection factor	dB	State the frequency dependence within the stated tolerances as well as other conditions for test (for example, filter settings, voltage limits)	6.8.2.1	*m*
9.	*Information input*(*s*) :				
	a) Input arrangement with respect to common point		Symmetrical asymmetrical or difference input		*m*
	i) With respect to ground		Grounded, floating		*m*
	ii) Screening		Yes/no, guarded input		*m*
	iii) With amplifier		Yes/no, for all or some ranges		*m*
	iv) With input filter		Yes/no, filter disconnectable		
	b) Impedances :				
	i) Between input terminals	Ω and pF	Maximum and minimum value	6.8.1	*m*

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

SL No.	TERM	UNIT	ANSWER OR REMARKS	REFERENCE TO TEST CLAUSES	STATEMENT
(1)	(2)	(3)	(4)	(5)	(6)
	ii) To common point(s) between common points and to ground	Ω and pF	State as applicable	6.8.1	*m*
	iii) Input impedance	Ω and pF	With non-operative apparatus	6.8.1	*m*
	iv) Source impedance, Maximum	Ω and pF	State if different for different measurement/conversion ranges	6.8.1	*m*
	c) Voltages				
	i) Maximum value between input terminals	V	Without damage to the apparatus	—	*m*
	ii) Rated common mode or floating voltage	V	Without infringement of the safety of the apparatus	—	*m*
	iii) Maximum common mode or floating voltage	V	Without damage to the apparatus	—	*m*
	iv) Spurious feedback	V, mA	For statements, *see* also **6.8.3**	6.8.3	*m*
10.	*Time function*				
	a) Conversion rate	s^{-1}	State maximum and minimum values	6.8.4.1	*m*
	b) Response times:		State separately for each setting of the input filter control	6.8.4.2	*m*
	i) Step response time	s			*m*
	ii) Polarity response time	s			*m*
	iii) Range response time	s			*m*
	c) Recovery time	s		6.8.4.3	*m*
	d) Conversion time and other time function components	s	As applicable		*o*

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

SL No.	TERM	UNIT	ANSWER OR REMARKS	REFERENCE TO TEST CLAUSES	STATEMENT
(1)	(2)	(3)	(4)	(5)	(6)
11.	*Auxiliary signals*				
	a) Conversion command		State voltage, voltage tolerance, polarity, impedance, maximum frequency, trigger point (leading or trailing edge of pulse)		*m*
	b) Signal conversion completed		State when with respect to the signal the output may be valid and when the next conversion command may be generated		*m*
	c) Other auxiliary signals		As applicable		*m*
12.	*Calibration source*				
	a) Calibration source		Internal and/or external, standard cell or other source		*m*
	b) Calibrating voltage	V	—		*m*
13.	*Power supply*				
	a) Type of supply		Mains and/or battery		*m*
	b) Supply voltage	V	Reference value(s) or reference range(s)		*m*
	c) Supply frequency	Hz	Reference value(s) or reference range(s)		*m*
	d) Power consumption	VA, W			*m*
14.	*Accessories*		State whether included or optional, also whether or not interchangeable		*m*
	a) Probes				*m*
	b) Filters				*m*
	c) Other accessories				*m*

(*Continued*)

TABLE 5 STATEMENTS TO BE PROVIDED IN INSTRUCTION MANUAL — *Contd*

SL No.	TERM	UNIT	ANSWER OR REMARKS	REFERENCE TO TEST CLAUSES	STATEMENT
(1)	(2)	(3)	(4)	(5)	(6)
15.	*Miscellaneous*				
	a) Design		For example, portable, trolley mounted, rack type		*m*
	i) Dimensions:		Over projections	—	
	Height	mm			
	Width	mm			
	Depth	mm			
	ii) Mass	kg	Normal accessories included	—	*m*
	b) Protection		According to IS : 2147-1962*	—	*m*
	i) Safety class	—	—	—	*m*
	ii) Connection of protective earth terminal	—	To the enclosure, to a screen or via intermediate devices	—	*m*
	c) Electromagnetic radiation:				*m*
	i) Conducted interference:	—		—	
	— symmetrical	μV			*m*
	—asymmetrical	μV			*m*
	ii) radiated interference	μV/m		—	*m*
	d) Cooling		Natural/forced		*m*
	i) Air consumption	m^3/h		—	*o*
	e) Electronic components:				
	i) Replacement			—	*m*

Degrees of protection provided by enclosures for low voltage switch gear and control gear.

APPENDIX A

(*Clause* 6.2)

INFLUENCE QUANTITIES

A-1. INFLUENCE QUANTITIES

A-1.0 The following influence quantities are relevant.

A-1.1 Environmental Conditions

NOTE — For test methods reference should be made to IS : 9000*.

A-1.1.1 *Climatic Conditions*

a) Ambient temperature
b) Relative humidity of the air
c) Barometric pressure (altitude)
d) Heating effect due to solar radiation
e) Velocity of the ambient air
f) Sand and dust
g) Salt
h) Contaminating gases
j) Liquid water (condensation, fog, drip and splash-water)

A-1.1.2 *Mechanical Conditions*

a) Operating position
b) Ventilation
c) Vibration
d) Bump
e) Mechanical shock
f) Sound pressure

A-1.1.3 *Field and Radiations*

a) Electric fields
b) Magnetic fields
c) Ionizing radiations

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*Basic environmental testing procedures for electronic and electrical items.

A-1.2 Supply Conditions

A-1.2.1 *Mains Supply*

a) Mains supply voltage
b) Mains supply frequency
c) Distortion of alternating mains supply
d) Other distortions
e) Internal resistance of mains supply
f) Potential of the protective conductor
g) Ripple of dc supply

A-1.2.2 *Battery Supply*

a) Dry cell supply voltage
b) Lead acid cell supply voltage
c) Alkaline cell supply voltage

A-1.3 An agreement between the manufacturer and user is recommended in the case of influence quantities which are not listed herein or of a combination of values which are likely to result in abnormal effects.

A-2. USAGE

A-2.1 The rated ranges of use of the influence quantities specified in **A-1** may be divided into the following three usage groups:

a) For indoor use and under conditions which are normally found in laboratories and factories and where apparatus will be handled carefully.
b) For use in environmental having protection from full extremes of environment and under conditions of handling between those of Groups (a) and (c).
c) For outdoor use in areas where the apparatus may be subjected to rough handling.

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‡Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road, BANGALORE 560058	839 49 55
Gangotri Complex, 5th Floor, Bhadbhada Road, T.T. Nagar, BHOPAL 462003	55 40 21
Plot No. 62-63, Unit VI, Ganga Nagar, BHUBANESHWAR 751001	40 36 27
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5-8-56C, L.N. Gupta Marg, Nampally Station Road, HYDERABAD 500001	20 10 83
E-52, Chitaranjan Marg, C-Scheme, JAIPUR 302001	37 29 25
117/418 B, Sarvodaya Nagar, KANPUR 208005	21 68 76
Seth Bhawan, 2nd Floor, Behind Leela Cinema, Naval Kishore Road, LUCKNOW 226001	23 89 23
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